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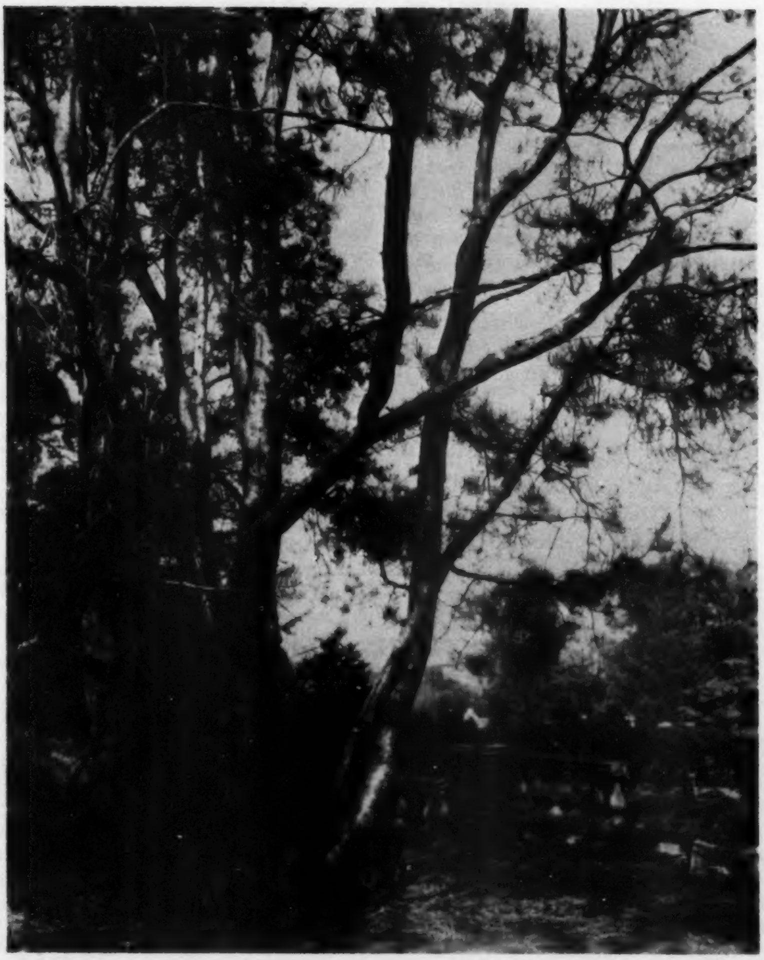

The Lacebark Pine, *Pinus Bungeana*

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Arboretum Activities

March Storm

The severe snow storm which ravaged this area on March 21 wrought tremendous havoc at the Arboretum. In fact the damage suffered here was comparable only to that inflicted by Hurricane Hazel in the autumn of 1954.

The number of trees actually destroyed by the storm was amazingly small and nothing of great value was lost. The real tragedy lay in the mutilation of many fine mature specimens and the widespread damage to evergreen shrubbery either through the sheer weight of wet snow or by the crashing of large branches from nearby trees.

Strangely enough, the sections of the grounds least affected were the ridge between Gates Building and the Mansion and the north slope. Here, apparently, the wind kept the snow from accumulating on the branches, whereas in the low "protected" hollows of the south slope the full weight of the snow lay inches deep on everything.

(Continued on Page 35)

Characteristics and Identification of the Soft Pines Cultivated in the Philadelphia Area

JONATHAN W. WRIGHT[1]

INTRODUCTION

The Philadelphia area has one of the most complete collections of soft or white pine varieties and species in the world. There are two reasons for this: the region has long been a botanical center, and the white pines find Philadelphia to their liking. Most of the white pine species are found only in arboreta or large estates. However, several would prove useful in the row-house gardens, suburban yards, and forests of southeastern Pennsylvania.

The white pines come in a variety of shapes and sizes. The bristlecone pine *(Pinus aristata* Engelm.) becomes one of America's oldest trees, but is typically slow growing and shrubby. It could safely be used in foundation plantings underneath a front picture window. So could the dwarf stone pine *(P. Strobus* L. var. *nana* Carr.).

The row-house dweller who wishes an erect small tree can use the Swiss stone pine (*P. Cembra* L.) or the Macedonian white pine (*P. peuce* Griseb.). The former grows about 4 inches per year; the latter 8 to 10 inches per year. Both are single-stemmed and have narrow conical crowns. Both are capable of becoming large trees, but not in the average man's lifetime.

The lacebark pine (*P. Bungeana* Zucc.) can find a place in almost any garden. It grows about one foot per year and typically is a many-stemmed large shrub or small tree. Its sparse foliage sheds very light shade in the shelter of which violets and other semi-shade flowers can thrive and bloom profusely. (Fig. 10)

The suburbanite with a half-acre lot has his choice of these or larger species. The eastern white pine (*P. Strobus* L.) is commonly planted and grows rapidly. It makes a compact evergreen hedge if clipped regularly. The Himalayan white pine (*P. Griffithii* McClel.) grows nearly as fast and becomes a large tree. (Fig. 11) It has long, graceful, drooping needles, and casts a light shade. The limber pine (*P. flexilis* James) is also a fast grower and frequently looks like an exceptionally dense and blue form of eastern white pine. (Fig. 12) The Korean white (*P. koraiensis* Sieb. & Zucc.), Armand (*P. Armandi* Franchet), Mexican white (*P. ayachahuite* Ehrenb.) and Japanese white pines (*P. parviflora* Sieb. & Zucc.) are other species that reach large sizes and make specimen trees. (Figs. 13, 14, 15).

The forestry possibilities of the exotic soft pines have barely been investigated. In several areas of New York western white pine (*P. monticola* Dougl. ex D. Don) compares favorably with native species. (Fig. 16) It is finer branched and much more weevil-resistant than the eastern white pine, and is fast growing. The Himalayan and Mexican white pines should be tested in the warmer parts of the region. The very hardy Korean white pine should prove useful as a timber and nut producer in cold regions.

IMPORTANCE OF WHITE PINES

The early New England settlers were impressed with the eastern white pine. They had seen nothing like it in old England or northern Europe. Its tall straight trunks were just the thing for masts for England's men of war, and the best trees were marked with a broad arrow and saved for the King's navy. The colonists found eastern white pine good for houses, too. This species furnished the lumber for many New England mansions that are still livable after 100 or more years. If eastern white pine has at times fallen from favor, it is only because of overcutting. At present it is again important, even though the present stands do not produce the high quality, knot-free lumber that came from the virgin forests. Even low quality white pine is in demand for pine panelling, boxes, and pattern stock. As the center of the lumber industry moved to the far West in the early years of this century, other white pine species were cut. Western white pine formed the mainstay of the lumber industry of the Inland Empire. In California, lumbermen found the sugar pine (*P. Lambertiana* Dougl.), the largest of all pines, to be a valuable species. Lumber of all three of these species is used inter-changeably although the western species are practically the only source of knotfree boards.

[1]) Associate Professor of Forestry at Michigan State University, East Lansing, Michigan. Most of the observations recorded in this article were made when Dr. Wright was geneticist at the Northeastern Forest Experiment Station of the U.S. Forest Service. The forest genetics work is in cooperation with the Morris Arboretum of the University of Pennsylvania at Philadelphia, Pennsylvania.

Fig. 10. The Lacebark pine, Morris Arboretum.

The woods of all the white pines are similar in being soft, durable, easily worked, not subject to warping after being properly dried, and capable of holding paint well. Thus, any of the species could form the basis of a large lumber industry. However, only two other species – Korean white and Himalayan white pines – grew in sufficient quantity to have provided the basis for anything except local industry. For example, the limber pine grows in high, inaccessible locations in the Rocky Mountains and is frequently wind blown and crooked. Thus, it is rarely used for lumber even though its wood is potentially valuable.

The properties which make white pine wood suitable for many building purposes also make it excellent for matches, and most American wooden matches are made from eastern or western white pine. Strangely, this is a very demanding use, and matches are made from the highest quality rather than the lowest quality lumber. The white pines make poor pulpwood and paper and are rarely cut for this purpose.

In the southwestern United States, Korea, and Afghanistan there are large-seeded white pines which are used as sources of human food. The southwestern tree is known as the pinyon (*P. cembroides* Zucc.). The seeds are collected by the Indians and are included in many brands of mixed nuts. The Korean white pine has seeds more than one-half inch long. In good seed years these seeds form an important source of food in Korea and Japan. It is a pity that the Afghanistan Gerard pine (*P. Gerardiana* Wall.) is probably not hardy in our area because its nuts are extremely large and tasty.

The barks of the white pines contain many chemical compounds but there is no record of even minor industries having utilized these compounds.

The white pines are occasionally used as Christmas trees. A few winters ago I noticed young Himalayan white pine decorating a store front in Norristown, Pennsylvania. The long, drooping foliage had been lightly sprayed and was effective without tinsel or other ornament. Two winters ago a Detroit dealer received the exorbitant price of $20.00 for a single young eastern white pine. Evidentally the buyer liked the tree and did not know that it was one of Michigan's commonest species.

The cut boughs of eastern white pine are commonly included in Christmas wreaths. And one Philadelphia nurseryman who has a few old Himalayan white pines occasionally sells small branches with cones attached. They are in demand because this species produces the largest cones of any pine growing in the state. The very

Fig. 11. A large Himalayan white pine at Morris Arboetum.

Fig. 12. Limber pine, Morris Arboretum.

large cones of sugar pine are common home decorations. When so used they are prepared by dipping in boiling water to spread the resin in a thin, shiny layer.

As proof of their popularity and importance the white pines are the state trees of several states: eastern white pine — Maine, Michigan, and Minnesota; western white pine — Idaho; and pinyon — Nevada.

Botanical and Genetical Classification

The genus *Pinus* is divided into two sub-genera, HAPLOXYLON (white or soft pines) and DIPLOXYLON (hard pines). These could be recognized as genera because they are as distinct from each other as are the spruces from the firs. The sub-genus HAPLOXYLON is characterized by having leaves with one fibro-vascular bundle, usually without stomata on the back; bracts of leaf-bundles not decurrent on the branchlet; leaf-bundle sheaths deciduous; wood soft, with little resin and with indistinct annual rings; and male flowers appearing in the spring.

The sub-genus HAPLOXYLON is in turn subdivided into two sections, six series, and about 25 species. Keys to the series and hardy species are given in table 1. These keys were prepared from Elwes and Henry (1909), Little (1953), Martinez (1948), Rehder (1940), and Sargent (1905).

Table 1. Key for the identification of white pine series and species that are hardy or probably hardy in Philadelphia.

Key To Series

A. Leaves in bundles of five; conelets unarmed; umbo of cone scales terminal, covered with resin; mostly 1-stemmed trees.
Sect. CEMBRA

B. Cones ovoid or conic-ovoid; cone scales fleshy, usually reflexed at tips.

C. Cone indehiscent; seeds wingless.
CEMBRAE

(P. koraiensis, P. pumila, P. Cembra, P. albicaulis)

CC. Cones dehiscent; seeds winged.
FLEXILES

(P. flexilis, P. strobiformis, P. Armandi)

BB. Cones cylindric or conic-ovoid; cone scales thin, usually appressed. STROBI

(P. Lambertiana, P. ayachahuite, P. parviflora, P. peuce, P. Griffithii, P. monticola, P. Strobus, P. formosana)

AA. Leaves in bundles of one to five; scales of conelets armed with a short prickle; umbo of cone scale armed with a prickle or spine, not covered with resin; mostly many-stemmed trees or large shrubs. Sect. PARACEMBRA

Fig. 13. Korean pine, Morris Arboretum.

C. Leaves entire, 1 to 2 inches long; bark ridged or flaky, dark gray.

D. Leaves in bundles of one to four; seeds wingless. CEMBROIDES

(P. cembroides, P. edulis, P. monophylla, P. quadrifolia, P. Pinceana, P. Nelsoni)

DD. Leaves in bundles of five, without stomata on back; seeds winged. BALFOURIANAE

(P. Balfouriana, P. aristata)

CC. Leaves serrulate, stout, sharp-pointed, 2 to 4 inches long; bark light-colored, exfoliating in large scales. GERARDIANAE

(P. Gerardiana, P. Bungeana)

Fig. 14. A young tree of the Armand pine, Morris Arboretum.

Key To Species[2]

A. Leaves in bundles of five.

B. Leaves serrulate, rough to touch when rubbed backwards.

C. Shrubs without a single central stem; leaves 2 to 3 inches long; cones ovoid, 1 to 2 inches long. *P. pumila**

CC. Trees with a single central stem.

D. Leaves 5 to 8 inches long, bent, drooping; foliage thin; branchlets brittle, covered with bloom; cones long-stalked (stalks 1 to 2 inches long), borne over entire crown. *P. Griffithii*

DD. Leaves 2 to 6 inches long, not bent; branchlets not bloomy; cone-stalks less than ½ inch long.

E. Branchlets tomentose or pubescent.

F. Trees narrow-pyramidal, horizontal-branched, growing 4 to 5 inches per year; cones indehiscent, 2 to 3 inches long, borne only in top of crown. *P. Cembra*

FF. Trees conical or broad-crowned, growing more than 10 inches per year.

G. Bark of trunk orange, flaky; cones 4 to 6 inches long, indehiscent; cone scales thick, with recurved tips. *P. koraiensis*

GG. Bark of trunk gray, smooth or fissured; cones dehiscent; cone scales thin.

H. Leaves bluish green, without stomata on back.

I. Foliage dense; leaves 2 to 6 inches long; cones short-stalked, cylindric, 4 to 12 inches long.

J. Trees conical; leaves 2 to 4 inches long; cones 4 to 10 inches long; cone scales appressed at tips. *P. monticola*

JJ. Trees broad-crowned; leaves 4 to 6 inches long; cones 8 to 16 inches long; cone scales reflexed at tips. *P. ayacahuite*

II. Foliage sparse; leaves 1 to 3 inches long; cones 2 to 4 inches long, ovoid, sessile. *P. parviflora*

HH. Leaves with conspicuous stomatic bands on back, stout, 3 to 4 inches long; cones 10 to 20 inches long. *P. Lambertiana**

EE. Branchlets glabrous or pubescent for only a short time.

F. Narrow-crowned trees growing 8 to 12 inches per year, with ascending branches; cone scales thin, convex; cones short-stalked, sub-cylindric, 3 to 6 inches long. *P. peuce*

FF. Broad-crowned trees growing 12 inches or more per year, with horizontal branches.

G. Buds cylindric, chestnut brown; branchlets coarse; cones 4 to 8

[2] Species marked with an asterisk are not present in Philadelphia.

inches long, ovoid, heavy; cone scales thick. *P. Armandi*

GG. Buds ovoid, tawny; cones cylindric; cone scales thin.

H. Cones 8 to 16 inches long; cone scales reflexed. *P. ayacahuite*

HH. Cones 3 to 8 inches long; cone scales appressed; branchlets fine. *P. Strobus*

B. Leaves entire, persistent 5 or more years, smooth to touch when rubbed backwards; cone scales thick.

C. Leaf sheaths deciduous soon after leaf expansion; leaves with stomata on back, 2 to 4 inches long, persistent for 5 to 6 years; cones unarmed; branchlets tough, flexible; seeds wingless; cones 2 to 9 inches long.

D. Leaves stout, 2 to 3 inches long; unripe cones purple, 2 to 3 inches long, indehiscent; bark of trunk broken into light brown or white platelike scales. *P. albicaulis**

DD. Leaves slender, 2 to 4½ inches long; unripe cones green, 3 to 9 inches long, dehiscent; bark of trunk dark grey.

E. Cones 3 to 6 inches long; cone scales rounded at tip, not reflexed; bark of trunk plated. *P. flexilis*

EE. Cones 4 to 9 inches long; cone scales reflexed; bark of trunk deeply ridged. *P. strobiformis*

CC. Leaf sheaths persistent for one or two years; leaves without stomata on back, 1 to 2 inches long, persistent for 10 or 12 years; cones armed with a prickle; seeds winged.

D. Branchlets light orange, glabrous; leaves dotted with resin; cones 2 to 4 inches long, armed with a long, slender prickle; usually a shrub. *P. aristata**

DD. Branchlets dark orange-brown, puberulous; leaves not dotted with resin; cones 3 to 5 inches long, armed with a short, incurved prickle. *P. Balfouriana**

AA. Leaves in bundles of one to four; small trees, usually many-stemmed.

B. Leaves in bundles of three, serrate, light green; bark exfoliating in large scales, leaving a smooth, whitish bark mottled with orange or brown; seeds with short wings. *P. Bungeana*

BB. Leaves dark green, entire; bark dark gray; seeds wingless.

C. Leaves in bundles of one (or two). *P. monophylla*

CC. Leaves in bundles of two (or three). *P. edulis*

CCC. Leaves in bundles of three (or two). *P. cembroides**

CCCC. Leaves in bundles of four (or three to five). *P. quadrifolia**

It is usually possible to identify a white pine with certainty even though it does not bear cones. The slow growth and short horizontal branches are characteristic of the Swiss stone pine. So, too, are the planetree-type bark of lacebark pine and the long, bent needles of Himalayan white pine.

In recent years the chemistry of the white pine has been under study in California (Mirov, 1953). The results indicate that the species are as distinct with regard to chemical composition of their resins as they are in external morphology and growth habit. For example, the whitebark pine is the only white pine species that lacks the turpene alpha-pinene. These studies, in addition to being interesting taxonomically, should shed light on the problem of pest resistance.

Across the northern United States and southern Canada there is a network of research agencies that devote the major portion of their efforts to white pine improvement. These researchers keep in constant touch with each other.

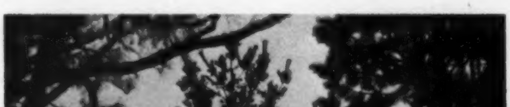

Fig. 15. One of the main stems of a large Japanese white pine, Morris Arboretum.

Pollen from Morris Arboretum has been used in Maple, Ontario; Madison, Wisconsin; Clarkia, Idaho; Placerville, California; and Ely, Minnesota, and pollen from these locations has been used on Morris Arboretum trees. And every year for the past seven years these workers have exchanged information by newsletter.

These genetic studies are farthest advanced in the field of species hybridization. Most of the species in the 5-needled section CEMBRA have been used as parents in one or more interspecific crosses (table 2). On the whole, the ease with which two species can be crossed is correlated with the closeness of their taxonomic relationship. With the single exception of sugar pine, species in the series *Strobi* cross easily with each other, but not with members of other series. Several species hybrids, including *P. flexilis* × *Griffithii, P. ayachahuite* × *Strobus, P. ayacahuite* × *Griffithii, and P. Strobus* × *monticola,* appear to be very fast growing and to hold promise for northeastern foresters.

The success symbols used are:

H= Hybrids produced and authenticated.
U = Undetermined. Full seeds produced but yet authenticated.
F = Failure.
A = Attempted. Success not yet known.

The study of geographic variation within species is progressing slowly. We know a little about the variability of western white pine but the first serious study of geographic variability in eastern white pine was started only in the fall of 1955.

For several years workers in Wisconsin and Washington have been diligently searching for individual trees resistant to the blister rust fungus. They have been successful and are now trying to breed resistant strains.

Synopsis By Species[3]

In the Philadelphia area there are thrifty, living representatives of 13 of the approximately

[3] Much of the information in this section was taken from a forthcoming publication by W. J. Gabriel and the author.

Table 2. Summary of species crosses made within the section CEMBRA. (Compiled from unpublished data in the files of the Northeastern Forest Experiment Station.)

Series and Species	Series and Species															
	CEMBRAE				STROBI				FLEXILES							
	koraiensis	pumila	Cembra	albicaulis	flexilis	strobiformis	Armandi		Lambertiana	ayacahuite	parviflora	peuce	Griffithii	monticola	Strobus	formosana
CEMBRAE																
koraiensis																
pumila	—															
Cembra	A	—														
albicaulis	F	—	F													
FLEXILES																
flexilis	F	—	F	—												
strobiformis	—	—	—	—	F											
Armandi	U	—	—	—	U	F										
STROBI																
Lambertiana	H	—	—	F	F	F	H	—								
ayacahuite	F	—	F	—	H	—	—	—	H							
parviflora	—	—	F	—	F	—	—	—	F	—						
peuce	F	—	—	—	—	—	—	—	F	—	H					
Griffithii	—	—	F	—	H	—	F	—	F	H	H	U				
monticola	U	—	—	—	A	—	U	—	F	H	H	H	H			
Strobus	F	—	F	F	H	—	F	—	F	H	H	H	H	H		
formosana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Strobus var. chiapensis	—	—	—	—	—	—	—	—	—	—	—	—	U	—	—	—

Fig. 16. Western white pine, Morris Arboretum.

25 white pine species. These are treated in detail later.

Another eight species are known to grow in the Northeast, and would probably prove hardy in Philadelphia. The western American bristlecone pine (Fig. 17) is one that should certainly be tried. Several years ago it was grown in quantity by the New York state forestry nursery near Saratoga Springs. One bunch of seedlings that was heeled in a crowded trench has remained alive for 20 years. Another was outplanted on an old field in the Adirondacks and is now a group of 3- to 8-foot-tall shrubs perfect for foundation plantings.

The border white pine (*P. strobiformis* Engelm.) from Arizona and northern Mexico grew faster than eastern white pine in forest plantings in Montgomery County, New York. (Fig. 18). This species is poorly known and has at various times been called *P. reflexa* Engelm. and *P. flexilis* var. *reflexa* Engelm. or has been confused with Mexican white pine. The 35- to 40-foot trees in these plantings have swollen nodes and deeply ridged lower bark, reminiscent of the bark of the chestnut oak (*Quercus prinus* L.).

There are two old grafted trees of the California sugar pine in the Arnold Arboretum in Boston. At the Morris Arboretum the seeds germinated, the seedlings grew rapidly, survived the critical first two winters, but failed to survive transplanting.

The Mexican and Parry pinyons (*P. cembroides* Zucc., and *P. quadrifolia* Parl.) are so similar in range and habit to the singleleaf pinyon and pinyon (*P. monophylla* Torr. & Frem., and *P. edulis* Engelm.) that they will probably prove similar to those species in ability to grow in the Philadelphia area.

I have not seen northeastern specimens of the whitebark pine (*P. albicaulis* Engelm.), the foxtail pine (*P. Balfouriana* Grev. & Balf.), or the dwarf stone pine (*P. pumila* (Pallas) Regel), but Rehder (1940) lists them as growing in this region.

There are four species of white pines that will probably not prove hardy in Philadelphia. The Formosan white pine (*P. formosana* Hayata) was grown in the Northeastern Forest Experiment Station's experimental nursery one year. It grew rapidly but the leaves were brown long before Christmas and none of the seedlings survived their first winter. The Afghanistan Gerard pine, the Mexican Pince pine (*P. Pinceana* Gord.), and the Mexican Nelson pine (*P. Nelsoni* Shaw) all come from regions with relatively warm winters.

Fig. 17. This slow-growing bristlecone pine would be ideal at the corner of a house.

Fig. 18. The little-known border white pine gets off to a slow start but then grows as rapidly as do some of our native species.

The following comments apply to species that have been tested in southeastern Pennsylvania.

ARMAND PINE *(P. Armandi* Franchet)

Armand pine is a native of southwestern China, where it grows at elevations of 4,000 to 6,000 feet, and reaches heights of 50 to 60 feet. This species has proved hardy at Rochester, New York, where the 40- to 50- year-old specimens are now about 50 feet tall. Younger specimens at the Morris Arboretum are growing vigorously, but exhibit slight winter dieback. (Fig. 14). These differences are possibly due to differences in seed origin, and further seed importations should be from the coldest parts of the species' range. A hardy race would be in demand because of its relatively long needles and blue-green foliage.

Armand pine has one peculiarity that the tree breeder likes. It flowers early without special urging. Even 3- to 5-foot specimens regularly produce abundant pollen.

EASTERN WHITE PINE *(P. Strobus* L.)

Eastern white pine is the most wide ranging and important of all the white pines. It grows naturally from the maritime provinces to western Ontario and Minnesota, and south along the Appalachian Mountains to northern Georgia.

The Chiapas white pine *(P. Strobus* var. *chiapensis* Martinez) of Guatemala and southern Mexico looks like eastern white pine, and grows in company with about 500 species of mosses, herbs, shrubs, and trees that are normally considered Appalachian species. It also grows with palms, orchids, and coffee. Strangely, this representative of a northern species grows at the lower part rather than the higher part of the Mexican pine forest. Several years ago Chiapas white pine was tried in Philadelphia. It promptly winter-killed.

Eastern white pine grows well in Philadelphia. On good soils isolated trees grow about 0.6 inches per year in diameter and about 2 feet per year in height. Yet it was not native, probably because it cannot set good seed. The Philadelphia trees flower regularly, but the cones contain an average of 1.1 good seeds per cone, in contrast with yields of 40 to 70 good seeds per cone in native stands.

Foresters in many parts of the world find this species a useful addition to their forests. In Europe it is known as Weymouth pine (after Weymouth, England) and is widely planted in England, Germany, France, Italy and Rumania.

Fig. 19. A young tree of the Himalayan white pine, Morris Arboretum.

Fig. 20. Foliage of the Himalayan white pine.

Recently it has shown promise in southern Sweden. It is also used in Japan and South Korea. The New Zealanders have gone so far as to prepare volume tables. They could not use ours because it grows much more rapidly down under.

HIMALAYAN WHITE PINE *(P. Griffithii* McClel.)

The Himalayan white pine is a native of the Himalayan Mountains, where it grows from Nepal to Afghanistan at elevations of 6,000 to 12,500 feet.

Philadelphia and its suburbs contain numerous 60-year-old specimens, 60 to 70 feet tall and 1½ to 2½ feet in diameter breast high. (Fig. 11) These older trees were probably all started from seed at the same time and were probably sold by one of two nurseries—Andorra or Meehan's—which stocked them early in the century. Most of these oldsters are still growing vigorously in height and diameter, and many are the tallest trees in their neighborhoods. There are also old specimens of Himalayan white pine near Poughkeepsie, New York and in Rochester, New York and thrifty young specimens near Bethlehem, Pennsylvania. However, it has not proved hardy in the Adirondacks.

The long, drooping needles and the large spreading branches gives this species a peculiar grace not found in other hardy pines. (Figs. 19 and 20). It is definitely not a tree for the small garden. However, it can be used in the medium-sized yard to furnish light shade under which semi-shade plants can be grown.

The seeding habits of this species are puzzling. Several times I have collected more than a half a bushel of cones from a tree that seemed adequately pollinated, only to find that the seeds were nearly all empty. Yet a nearby tree might yield almost a quart of viable seeds the same year.

JAPANESE WHITE PINE

(P. parviflora Sieb. & Zucc.)

The Japanese white pine is a native of the mountains of Japan and the Kurile Islands. In its native habitat it is a species of poor timber form and moderate growth rate, and is of little commercial importance. However, it is used in Japanese gardens.

The branches of the Japanese white pine are not exceptionally large, but they are long. Even in young trees the crowns are frequently as broad as tall. The blue-green foliage is shorter than in most white pines.

The Morris Arboretum contains two specimens which were planted as parts of Japanese gardens. They have picturesque, crooked trunks —possibly as the result of early training. (Fig. 15) Specimens in other Philadelphia arboreta have straight trunks.

The seeds of Japanese white pine are so large in comparison with the size of the cone that they cause noticeable bulges in the ripe cones. Therefore, even without X-ray eyes, it is possible to count the number of full-sized seeds — but not to tell how many are filled — in unopened cones.

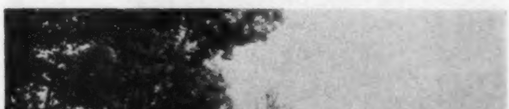

Fig. 21. The Macedonian white pine nearly always has a regular, conical crown.

KOREAN WHITE PINE

(*P. koraiensis* Sieb. & Zucc.)

Korean white pine is an important timber and nut tree of the mountains of Korea and Manchuria. Judging from the rigorous climate of its homeland, it should be among the hardiest of the white pines – possibly even hardier than eastern white pine.

The illustration accompanying the original description and the original Latin diagnosis apply to a composite specimen made up to parts of Korean white, Japanese white and dwarf stone pines. This description appeared in 1844 but verbatim copies or translations appeared in the taxonomic works of other authors until about 1890.

The two Morris Arboretum trees (one is now dead) grew a few inches per year (Fig. 13) whereas each of the three specimens in the Westtown School Arboretum near Westchester, Pennsylvania grew more than 1½ feet in height per year. This extreme difference is probably due in large part to differences in geographic origin of the seed. The handsomest specimen I have seen is on grounds of the former Cluett estate, near Williamstown, Massachusetts. That 35-year-old tree is 60 feet tall, 10 inches in diameter breast high, and has a perfectly straight trunk. At first glance one thinks he has made a dendrological mistake. The bark is just like that of red pine (*P. resinosa* Ait.) but the bundles are 5-needled.

Fig. 22. This 26-inch Mexican white pine has outstripped eastern white pine in diameter but not in height growth.

LACEBARK PINE

(*P. Bungeana* Zucc.)

The lacebark pine is a native of western China, where it grows in open woodlands. Under natural conditions and in this country it is typically a branchy, many-stemmed small tree.

The most distinctive characteristic of lacebark pine is its bark, which exfoliates in layers and is colored like the bark of the planetree. Because of this bark there seems to be almost universal agreement among visitors to the Morris Arboretum that this tree is one that should be in every garden. (Fig. 10).

The lacebark pine is moderately fast growing, putting on about one foot in height per year. It seems to be quite hardy. A vigorous specimen in Ann Arbor, Michigan has stood winters colder than Philadelphia.

LIMBER PINE (*P. flexilis* James)

Limber pine is a tree of high elevations in the Rocky Mountains. Because of its inaccessibility and branchiness, it is of minor importance in its native range.

This tree gets both its common and scientific names from its pliable branches, which are a blessing to the tree breeder. When applying pollination bags I used regularly to break off a large percentage of the branchlets of the brittle-wooded Himalayan white pine. Not so with limber pine, the branchlets of which can be bent almost double.

A visitor from the Rocky Mountains would be amazed at the Philadelphia trees. They do not have a windswept appearance. Instead, they are straight-trunked and fast growing. In fact, a few specimens are outgrowing eastern white pines planted nearby.

This species has a peculiar branch habit (Fig. 12). Often the lower branches start to turn upward at the tips when the trees are about 20 feet tall. These branches then become secondary trunks. One 60-foot specimen now has a lower branch 50 feet tall.

The growth relations of limber and western white pines are puzzling. In the northern Rocky Mountains the former grows at higher elevations than does the latter. Therefore, the limber pine might be expected to grow better than western white pine in the cool Adirondacks and poorer than western white pine in warm Philadelphia. However, the reverse is true, for limber pine grows better in Philadelphia and western white

pine grows better in the Adirondacks. Differences in seed origin probably explain part of this anomaly.

Macedonian White Pine *(P. peuce* Griseb.)

Macedonian white pine (Fig. 21) is native to three small areas in the mountains of Greece, Bulgaria, and Yugoslavia, where it grows at elevations of 2,500 to 7,300 feet. In its native habitat it attains heights of 100 feet in 100 years, has excellent timber form, and is a locally valuable timber tree.

This species is typically moderately fast growing, with short, slender, ascending branches and a straight stem. It is uniform, and looks the same whether seen in Michigan, New York, Connecticut or Pennsylvania. In fact, the fastest growing specimen in Philadelphia (22 feet tall, 5 inches in diameter, breast high, about 20 years old from seed) has about the same dimensions as similar-aged trees in natural European stands.

Mexican White Pine *(P. ayacahuite* Ehrenb.)

The Mexican white pine (Fig. 22) is a taxonomically variable species of which three geographic varieties are recognized. Within its native range, which extends from Guatemala to northern Mexico, it is a high mountain species of local importance as a timber producer.

It is surprising that this species should be hardy in Philadelphia and Rochester, New York, yet specimens have survived about 40 winters in both places. Later importations from two localities in Mexico failed to survive the first winter.

In the Northeast this species grows faster in diameter but slower in height than eastern white pine. All trees are rather broad-crowned, and have denser foliage than the latter species. They produce many (1,000 or more per tree some years) large cones over the entire crown.

One 35-year-old tree in the Westtown Arboretum near Westchester, Pennsylvania has been a most faithful brood mare. The Northeastern Station has used it in tree breeding operations and year after year has obtained a bountiful crop of hybrid seeds. Sometimes these hybrids came with no effort – merely as the result of wind pollination from nearby eastern white pine. Young hybrids (Fig. 23) being tested near Philadelphia are growing about as fast as eastern white pine.

Pinyon (*P. edulis* Engelm.) and Singleleaf Pinyon (*P. monophylla* Torr. & Frem.)

These species grow in the Rocky Mountains from southern Idaho to northern Mexico and from southeastern California to extreme northwestern Oklahoma. They generally occur in open woodlands at the lowest limit of tree growth.

Fig. 23. Hybrids between Mexican white and eastern white pine show early promise of very rapid growth.

In their native habitats the pinyons are typically broad-crowned small trees which are valuable mainly for their large, edible (whence the name *edulis*) nuts. These nuts are gathered by the Indians and occasionally find their way into expensive nut mixtures.

The few specimens in Philadelphia are growing much as they would in their native, dry habitats. In fact, each looks as if it could have been transferred bodily from an Arizona landscape. This even refers to the seed production because occasionally the lone Morris Arboretum *P. edulis* produces selfed but full seeds. (Fig. 24)

Swiss Stone Pine *(P. Cembra* L.)

The Swiss stone pine is distributed widely in Siberia and in the mountains of central Europe. (Fig. 25). It is likely that most of the northeastern trees belong to the typical Swiss variety *(P. Cembra* var. *Cembra).* It derives its common name from the large seeds or "stones".

The Swiss stone pine is now too rare and inaccessible to be cut much for timber. However, it was used by prehistoric man in the Swiss lake dwellings.

In the Northeast the oldest and largest tree of which I have a record is on the Remington estate, Cazenovia, New York. Planted in 1856, it was 59 feet tall and 26 inches in diameter breast

high when measured in the spring of 1957..[4] Another large tree, 80 years old, 39 feet tall, and 18 inches in diameter breast high, grows near Beacon, New York. One Morris Arboretum specimen will soon reach this height but is much smaller in diameter. All the Swiss stone pines can be characterized as straight-boled, fine-branched, dense-foliaged, slow-growing, and ideal for small gardens.

Western White Pine

(*P. monticola* Dougl. ex D. Don)

Western white pine is one of the most important western American timber trees. (Fig. 16) It grows naturally in the Sierra Nevada and Cascade mountains of California, Oregon, and Washington, and in the northern Rocky Mountains of Idaho, Montana, and British Columbia. Its natural range is now shrinking considerably due to the ravages of the white pine blister rust.

[4] These measurements were furnished by E. W. Littlefield, Assistant Director, Division of Lands and Forests, Albany, New York.

Fig. 24. Pinyon pine, Morris Arboretum.

Fig. 25. The tall but compact Swiss stone pine makes an excellent specimen tree for small gardens.

Western white pine appears to be a slow starter but after 7 or 8 years it grows at about the same rate as eastern white pine. Except for form – it has a narrower crown and finer branches – it is similar in general appearance to the eastern species.

The few specimens in Philadelphia are growing well. A forest plantation near Saratoga Springs, New York is doing excellently. The trees are a little taller than nearby eastern white pine planted at the same time, and have only 20 percent as many weevilings. This lack of weeviling makes the tree of especial interest to foresters.

Eastern and western white pines can be crossed with ease, and the hybrids outgrow both of the parents. With further research these hybrids should prove very useful in the forests of the Northeast.

(To be continued)

Fertilizing Trees and Shrubs

Mary O. Milton

If trees and shrubs are to grow well they must have an adequate supply of nutrient elements, and if these nutrients are not naturally present in the soil they must be supplied by the application of fertilizers. Plants which are in a weakened condition from the lack of sufficient nutrients not only look unsightly, they are far less able to withstand droughts, severe winters, and are much more susceptible to damage by wind, insects and disease.

Forest trees which grow in their natural environment have only other trees to compete with for nutrients and water. Their roots and nutrient supplies are not restricted by streets and sidewalks, underground pipes, and buildings. The mulch of organic materials naturally supplied them replaces many of the elements taken from the soil by the normal growth of the trees. While the actual nutrients supplied by these organic materials are very low in comparison with commercial sources of mineral nutrients, it is regularly supplied, and mulches are of special benefits in improving and maintaining soil texture. On the other hand, ornamentals are often grown in open, closely clipped lawns, their roots subjected to drying, extreme temperature changes, and in many cases are grown in subsoil covered with an inch or so of top soil. In other words, ornamentals often have adverse growing conditions made worse by insufficient nutrient elements.

If a tree or shrub is growing well, flowering and fruiting in a satisfactory manner, in all probability it has available the elements necessary for maintenance and growth. Nutrient element deficiencies are normally evidenced by distorted or discolored foliage, sparse growth, and a general decline in vigor. However, sucking insects can cause yellowed, distorted leaves or borers can enter the trunk of a tree or shrub and produce symptoms much like those of nutrient deficiencies. Industrial gases, improper drainage, too much or too little shade may also be a cause for poor vigor. There are some symptoms that will, with a little practice, indicate what general deficiencies are present. The following table by Dr. Carl G. Deuber includes the more obvious ones.

Symptoms	Cause
1. Poor leaf growth which causes:	
a. Dwarf plants, yellowish color	lack of nitrogen
Dwarf plants, grayish color	lack of phosphorous or potash
b. Tall, spindly plants	lack of light
2. Chlorosis or yellowing of leaf	
a. Uniform all over leaf	lack of iron, excess of lime magnesium, sodium, potash, carbonates, manganese
b. Patchy, spreading from midrib outward	lack of magnesium
c. Mottled	lack of lime
d. Spotty	lack of potash
e. Leaf yellowing, then drying at tip and from edges inward	lack of potash
f. Leaf yellowing then drying from midrib outward	lack of nitrogen
3. Patches on leaf	
a. Brown patches like 'scorching'	lack of potash
b. Brown patches chiefly in center	lack of magnesium
4. Rich green leaves and large thick stems	large supply of nitrogen
5. Dark colored leaves, tendency to crinkle	lack of potash in relation to nitrogen
6. Patchy appearance of foliage, some dark green, others lighter	acidity of soil

The only truly reliable way to know just what elements are either lacking or are in overabundance is to have the soil tested by a reliable soil testing service such as the county agricultural agent. Often manufacturers of commercial fertilizers have a customer soil testing service. Samples should be collected from several different places in the growing area, one or two tablespoons from each spot, and taken from 2 or 3 inches below the surface. The soil should be dried before packaging to send away for testing.

It is a good policy first to determine the physical condition of the soil. While an application of fertilizer may serve as a "shot in the arm" and help overcome, or rather endure, adverse grow-

ing conditions it certainly will not cure all ills. No matter what the nutrient content of the soil, if there is improper drainage, poor soil texture, disease or insects, or it is too acid or too alkaline for the plants growing in it, plants will not thrive.

Fertilizers, both chemical and organic, are often referred to as plant foods. Actually they are not foods at all — they furnish the nutrients necessary for the manufacture of food. The green coloring in leaves, chlorophyll, manufactures the basic food for the plant, and if the nutrients necessary for the formation of chlorophyll are not sufficient, plants cannot maintain themselves.

Inorganic fertilizers are those obtained from mineral sources, and organic fertilizers are those obtained from animal or plant materials. The inorganic fertilizers are usually more quickly available, that is they can immediately be taken up and used by the plant, and are applied in smaller amounts and at shorter intervals than the organic fertilizers. Organic fertilizers are more slowly available and can be used without danger of burning the plant.

Of the many elements necessary for plant growth, nitrogen (N), phosphorus (P), and potassium or potash (K) are those used in greatest quantities. These three elements, N, P, and K, are the constituents of the familiar 5-10-5 fertilizers. These numbers indicate the proportion of nitrogen, phosphorous, and potassium, in that order, and are known as complete fertilizers. Actually they are not complete fertilizers since they do not contain all the elements known to be necessary for plant growth — they have become known as complete fertilizers because they supply the elements most commonly found lacking in soils. A 5-10-5 fertilizer has in a one-hundred pound bag, 5 pounds of nitrogen, 10 pounds of a phosphorous compound, and 5 pounds of a potassium compound, or 5 *parts* nitrogen, 10 *parts* phosphorous, etc. The remaining 80 pounds, or parts, serve as a carrier or spreader for the actual fertilizer. This carrier may or may not have nutrient value and it may have an alkaline, acid, or neutral reaction in the soil. In any case, the carrier facilitates the uniform application of the fertilizer.

Most trees and shrubs will respond satisfactorily to a complete fertilizer and unless the exact deficiencies are known they should be used rather than applying the specific elements alone. Usually fertilizers prepared especially for trees and shrubs are the most reliable and should be used by the average gardener. Some brand names are Agrico for Lawns, Trees and Shrubs, Vertagreen for Turf and Trees, and Espoma for Trees and Shrubs. Most of these fertilizers are 5-10-5, 10-8-6, or 4-6-4 N, P, and K ratios, and are effective and safe for general use. Sandy soils very low in organic matter will require a higher nitrogen content fertilizer and there a 10-6-4, 10-8-6, or 10-10-10 ratio should be used. No matter which prepared fertilizer is used, the directions on the package should be carefully followed.

Nitrogen promotes the vegetative growth of plants, and because it is so easily leached from the soil, it is the element most often found lacking. Plants can easily be damaged by nitrogen and care should be taken to apply the correct amount and to water it well into the ground after application. While trees and shrubs grown primarily for foliage require more nitrogen than do those grown for flowers or fruits, a high nitrogen fertilizer generally should not be used on hedges, as it will promote an undue amount of growth which will require frequent trimming. To induce flowering in shrubs it is often beneficial to reduce the nitrogen and increase the phosphorous and potassium content of the soil.

Some common sources of inorganic nitrogen are ammonium sulfate, calcium nitrate, nitrate of soda, and urea. These elements are quickly available and may burn the plant if care is not used in their application. Organic sources of nitrogen include activated sludge, cottonseed meal, tankage, dried blood, and animal manures.

Phosphorous stimulates root growth and development and increases flower and seed production. It is slowly available to plants and does not leach from the soil. It is often deficient in soils containing large amounts of composted materials and those which receive regular mulches. Common sources are superphosphate and ammonium phosphate.

Potassium promotes strong stems and branches, intensified flower color and is also thought to increase resistance to some diseases. Natural soils which have a high percentage of sand or peat usually have a low potassium content.

The following is a list of common fertilizers, their rates of application, availability, and soil reaction. The amounts given for dry application are for 100 square feet of soil area.

Sodium nitrate — 15% N; readily available; alkaline; dry application 1 pound liquid — 1 ounce per gallon of water.

Calcium nitrate — 15% N; readily available; very alkaline; dry application 1 pound; liquid — 1 ounce per gallon.

Ammonium sulfate — 20% N; readily available; acid; dry application 1-2 pounds liquid — 1 ounce per 2 gallons.

Urea — 46% N; readily available; acid; dry application ½ pound; liquid — 1 ounce per 7 gallons of water. When dry application is

made urea should be mixed with sand to assure uniform distribution.

Ammonium phosphate – mono 11% N, plus 48% P; moderately available; acid; 1-2 pounds; liquid 1 ounce per gallon.

Ammonium Phosphate – di 21% N, plus 53% P; moderately available; acid; 1 pound; liquid – 1 ounce per 5 gallons.

Superphosphate – 20% P; slowly available; neutral; dry application 4 pounds; insoluble in water.

Potassium sulfate – 50% K; readily available; neutral; dry application 1 pound; liquid – 1 ounce per 2 gallons.

Muriate of Potash – 50% K, readily available; neutral; 1 pound, liquid – 1 ounce per 2 gallons.

Some other elements used in lesser amounts are calcium, or lime, which aids in the taking up of N, P, and K by the plant, favors the development of soil bacteria necessary for the breakdown or decomposition of organic matter, and also makes more alkaline, or sweetens an acid soil. An overdose of lime may increase the alkalinity of the soil to a point beyond the range desired. This can prevent the plants using other elements contained in the soil. Iron is a rather common deficiency, and is often mistaken for a nitrogen deficiency. An application of the quickly available iron called chelated iron, will usually give good results. A trade name for chelated iron is "Sequestrene".

Acid loving plants which have been overcared for by the addition of too much acid peat, oak leaf mold, ammonium or aluminum sulfate or other materials which lower the acidity of the soil may also show many deficiency symptoms. This is due to the pH or acidity of the soil being too low to allow the plant properly to use the nutrients in the soil. When the acidity is brought up to a higher pH the nutrients are again available to the plant.

Other elements known as trace or minor elements such as manganese, boron, copper, and zinc are usually present in most garden soils. Deficiencies in these trace elements are best determined by soil tests. Very sandy soils, those low in organic matter, or soils that have been overlimed often are deficient in the trace elements. Many of the complete fertilizers contain these minor elements, and when they are present the label will state so. Fish emulsion and dried blood are very good organic sources of these elements. They can also be purchased in the quick acting or chelated form.

Trees and shrubs may be fertilized in the spring or in late fall after the leaves have fallen and before the ground has frozen to a point which makes application impractical. Foliage feeding is done of course when the tree or shrub is in full leaf. Late summer applications, especially of those fertilizers quickly available to the plant, will many times force soft new growth late in the growing season and will winter kill. Evergreens are particularly susceptible to winter kill from late fertilizing. Fall application has the advantage of making the fertilizer available for the first growth in the early spring, while results from spring application, especially after very dry summers, may not be gotten until the following year.

Large trees may require fertilizing every 3 years or so, and unless it is determined that nutrient deficiencies do exist, fertilizing more often than this may not only be an unnecessary expense, but the application of excessive amounts can seriously damage or even kill the plant. Young trees, especially young evergreens, respond more quickly to fertilizing and are therefore more easily damaged by an overdose. Fast growing shrubs may be fertilized every year or so – however, a reasonably good soil should not require such frequent fertilizing. Plants with special soil requirements such as azaleas, hollies, etc., should have a generous supply of organic materials incorporated in the soil. Roses may require feeding every year, and sometimes twice during the growing season. It very often happens that shrubs and trees live year after year and are perfectly healthy; again some must be fertilized quite often just to keep them alive. The frequency of applications will be determined by the soil conditions and the type of plant.

There are several opinions as to the correct dosage which vary from 1 to 8 pounds for each inch in trunk diameter three feet above the ground. Again, when using prepared brand name fertilizers, follow the directions on the package. A safe application for larger trees is from 2 to 4 pounds for each inch in trunk diameter at chest height. It is far better of course to make a second application than to risk seriously damaging the tree by too heavy an application. Small trees, those with a trunk diameter of less than 6 inches should have 1 to 2 pounds per inch of trunk diameter.

Narrow leaved evergreens such as pines, spruces junipers and hemlocks, are rather easily damaged by excessive amounts of commercial fertilizers. Very young trees of this sort can safely be fertilized with an organic fertilizer such as cottonseed meal or tankage. The nitrogen in these materials is slowly available to the plant, thereby reducing the possibility of burning the tree. This can be applied at the rate of about 5 pounds per 100 square feet, or about 2 cupfuls per plant. This should be scratched into the surface of the soil and watered in to mix well with the soil. Larger narrow-leaved ever-

greens can safely be fertilized with regular 5-10-5, or 4-8-4 commercial fertilizer at the rate of 2 pounds per inch of trunk diameter.

Organic materials such as sawdust, leaves, woodchips, peat, peanut hulls, etc., furnish small amounts of mineral elements. Their chief value is their ability to improve the texture of the soil, permitting better aeration and drainage when actually in the soil, and when applied as a mulch, protecting the roots from severe temperature changes and reduces water loss. While there is no doubt that animal manures are of decided benefit to the soil, their mineral nutrient content, with the exception of nitrogen is many times lower than that of a good complete fertilizer.

When sawdust or woodchips are used as a mulch, extra nitrogen should be applied to compensate for the nitrogen taken from the soil by the bacteria and fungi in decomposing them. When these materials are decomposed, the nitrogen is again available to the plant, but they do require a considerable amount to break them down.

Generally speaking, the feeding roots of trees are located within the radial spread of the branches, and it is in the outer two thirds of this area that fertilizers should be applied. They should never be applied in the area immediately around the trunk as there is danger of burning the base of the tree, and in addition, there are few feeding roots in this area. The roots of shrubs are of course, much more fibrous and are located closer to the main stems of the plant. The radial spread in feet of the roots of trees is usually equal to the trunk diameter in inches a foot or so from the ground. That is, a tree 8 inches in diameter would have a radial root spread of about 8 feet.

While commercial arborists often use compressed air drills for the application of fertilizers, possibly the most effective method of application for the home gardener is the punch bar method, the feeding needle, or spraying directly on the foliage. The feeding needles and foliage feeding have the decided advantage of the fertilizers being in solution when applied, and since plants do not use nutrients in a dry form, they are much more quickly available. While the fertilizers used in these needles are rather expensive in comparison with other methods they are easy to operate and their value in watering plants during severe dry periods cannot be underestimated.

The punch bar method requires a little more work. It is however very effective and while the fertilizers applied in dry form are not so quickly available, the results are much longer lasting and are recommended for feeding large shade trees. Holes may be punched with a crowbar, or any heavy rod, about 2 feet apart and from 15 to 20 inches deep. The feeding roots of most trees are located in the top 15 to 24 inches of soil and since most fertilizers, with the exception of nitrogen do not move about in the soil, it is necessary to place the fertilizer near the roots. These holes should not be punched in even rows, but staggered in order to furnish the nutrients to as much area as possible. The holes punched with a crowbar will be about 2 inches wide, and into these holes the dry fertilizer is poured. A funnel or paper cone may be used to direct the fertilizer into the holes — this not only makes sure the required amount is furnished, it avoids spilling and burning the lawn. The holes are then filled with either peat, leaf mold or top soil and the entire area well watered.

Foliage feeding or spraying fertilizers directly on the leaves of the plant does not give lasting results, but it is very effective when quick results are desired. Soluble fertilizers in the form of water soluble salts are available. These salts should be dissolved in water at the rate specified on the package. When applied to the foliage, the spray should be directly to the underside of the leaves since there is usually a greater number of pores, or stomata, located on the lower leaf surface and more of the solution is taken into the plant. If small shrubs are to be foliage fed, an ordinary flit gun will do nicely . . . for large trees such as maples, elms, beeches, etc., only high pressure sprayers can reach the leaves. When the solution drips from the foliage an adequate amount has been applied. The solution will not stick well on plants which have waxy leaves, such as roses, laurels, rhododendrons, pin oaks, etc., this may be overcome by adding about ½ teaspoon of Tide, Dreft, or other synthetic soaps to each 3 gallons of solution.

Most ornamentals grow best in a slightly acid soil — that is a pH range of 5.5 to 7.0. There are some however, which require a more acid soil. These include rhododendrons, azaleas, hemlocks, blueberries, mountain laurels, camellias, hollies, spruces, oxydendron, clethra, heathers and heaths, and bayberries. These plants should be fertilized with materials having either an acid or neutral reaction in the soil. There are several prepared fertilizers designed for these plants which are satisfactory. Hollytone is an example.

Unless a test for soil acidity determines that the pH of the soil has dropped below that which is best for the plant, it should not be fertilized with materials such as calcium nitrate, sodium nitrate, lime, or bonemeal. If the pH range has gone above that best for the plant it can be lowered by applying iron sulfate at the rates indicated below.

present pH	pH desired 4-5	5-6	6-7
5-6	3 lbs/100 sq. ft.	...	add lime
6-7	6 " "	3 lbs.	...
7-8	10 " "	6 lbs.	3 lbs.

Aluminum sulfate may also be used to acidify soils. It should be used with care however, since it can easily injure plants. Aluminum sulfate should not be used on rhododendrons and azaleas. Sulfur is a safe and reliable acidifier and can be used on almost all plants. Although it takes a longer time to lower the acidity, the results are more lasting than either aluminum or iron sulfate; it is applied at about 1 pound per 100 square feet of soil area.

It is far easier to maintain acidity in naturally alkaline soils by incorporating organic materials such as acid peat, leafmold, etc., than to try to keep it within the lower range by constant application of chemicals.

The amount of calcium or lime necessary to raise the pH of the soil will vary with the type of soil. From 4 to 6 pounds per 100 square feet of soil area for a sandy loam, and from 1/4 to 1/2 more than this amount for heavy clay soils.

Since so many fertilizer rates are for 100 square foot areas of soil the following comparisons may help in determining how much to use per plant. Mixed Fertilizers such as 5-10-5 may be applied at the following rates —

4 pounds per 100 sq ft. of soil = = approx. 2½ cups per plant spaced 5 ft. apart, or ½ cup spaced 2 ft. x 2 ft.

3 pounds per 100 sq. of soil = = 1½ cups per plant spaced 5 ft. apart, or 5 tablespoons spaced 2 ft. x 2 ft.

2 pounds per 100 sq. ft. of soil = = 1 cup per plant spaced 5 ft. apart, or 3 tablespoons spaced 2 ft. x 2 ft.

There are many different types and kinds of prepared fertilizers on the market — those especially prepared for roses, for trees and shrubs, for azaleas and rhododendrons, and for lawns. Most of these fertilizers are completely reliable and can safely be used on the plants they are designed for. However, one should beware of fantastic claims made by companies to the effect that their fertilizer will make diseased plants healthy, produce many times a normal rate of growth, etc. Plants can safely use a specific amount of nutrient elements, and used in correct combination with proper soil, light, and temperature requirements, will thrive. Satisfactory results above those that are normal for the plant are seldom obtained and should not be expected.

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Arboretum Activities

(Continued from Page 18)

Among the plants most badly damaged were some of the older conifers, especially *Thuja* and *Chamaecyparis.* One very handsome *Abies Vietchii* was almost completely ruined, as was a fine *Picea Maximowiczii.* Many of the smaller conifers as well as most of our boxwood, escaped branches had been bound together last autumn.

By some almost miraculous quirk our superb Atlas Cedars suffered a minimum of damage as did most of our larger pines. The hollies, on the other hand, were among the most badly hit and several of them will take many years to recover from the breakage of their leaders.

Among deciduous trees the flowering dogwoods were the most severely broken, yet already they have made new growth and give promise of rapid recovery. The hawthorns and sourgums were also badly injured.

Two of our worst victims were a magnificent Chinese Elm, *Ulmus parvifolia* and a fine old Siberian Elm, *U. pumila.* These two trees have required many hours of careful pruning and only time will reveal whether they can ever regain their handsome shapes.

Although beaten horizontal by the snow, most of our thousands of azaleas seem to have come through without permanent injury. The same may be said for most of our other low shrubs, although one Beauty Bush *(Kolkwitzia)* was practically decimated.

Damage to the greenhouses was fortunately slight, with the exception of a section of the palm house which lost some glass. The newly renovated fernery came through unscathed.

Warm praise is due the members of our staff who worked with unremitting energy to clean up the damage and restore the grounds to a condition of apparent normalcy. Much work still remains to be done, especially in the tops of the taller trees and in straightening up the smaller

conifers, but few visitors to the grounds today would realize that the Arboretum had been subjected to one of the worst storms in its history.

Seeds Received

In the last issue of the Bulletin reference was made to our practice of exchanging seeds of woody plants with other institutions in this country and abroad. At that time we mentioned the number of requests we had received for items on our own list, but said little about the benefits which we in turn derive from such an exchange.

It is now possible to state that during the last few months we have received seeds of over 550 species of trees and shrubs which we requested from other botanical gardens and arboreta. About 100 of these came from institutions in this country; the rest were received from gardens in the British Isles, Czeckslovakia, France, Germany, Hungary, Italy, Japan, Yugoslavia, Poland, Portugal, Russia, Spain and Switzerland.

According to their individual requirements these seeds will be subjected to cold, treated with acid or planted directly in flats. Following germination the young seedlings will be placed in a cool house or in the cold frame for a year or two before being transferred to the nursery where they will be tested for hardiness.

As this practice will be repeated in future years the increase in the Arboretum's representation of woody species will be considerable.

J. M. F. Jr.

Gardel—A Good Sign of the Times

Patricia Allison

Gardel is the name of one of the vigorous trade associations in our area, the Garden Supply Dealers of Delaware Valley. The formation and activities of such organizations in various parts of the United States represent the climax of the many transformations that have accompanied the movement of city dwellers to the suburbs.

The first of these transformations was probably the startling personal realization that home no longer extended from wall to wall, but from lot line to lot line. Next came the "plant furnishings" of the outdoor portion of the home and, of course, the increase in numbers of suburban nurseries and varieties of available plants. Caring for these outdoor furnishings soon consumed the interest of not only the homeowner in charge, but big business as well. Never before had there been such demand for tools; never before had agricultural industries taken it upon themselves to pass on their products and information to such "small operators" as homeowners; and never before had there been such a prodigious demand for information.

Consider the tool problems. The power mower, once the pride of gardening staffs of large estates, has undergone special redesign a hundred times over, and is now as ordinary outside the home as the vacuum sweeper is inside. The same sort of special designing, production, and marketing have brought sprayers into common usage, and have brought high quality hand tools of reasonable price.

Consider the pesticide problems. Not long ago the selection of materials for agricultural and home use alike was limited. It was agriculture that first received the benefits of organic chemical research, and for a time it was agriculture alone that was supplied with the large-package products. Now many of these same materials, with recommendations for small scale use, are available at garden suppliers, at hardware stores, and even in grocery stores.

Consider now the information problem. Who can tell us what "plant furniture" to buy, when to plant it and where to plant it. Who can guide us in our selection of new maintenance equipment and its use. Who can tell us what our insect problems are and thread through the maze of brand names to the correct material to use in solving them. Certainly not the same man who sells soap powder and soup, and probably not the same man who supplies us hinges and hammers.

First, there are newspapers, magazines, garden books, and government pamphlets to consult. Agricultural extension specialists spend a large proportion of their time with plant problems of the individual taxpayer. Industry has cooperated with clear directions for use of their products. In addition to these sources of information there is the conscientious specialist in garden supplies. Many of these men have realized that they must not confine themselves entirely to the art and technique of selling. In addition, they must supply information and service.

Gardel is a nearby group of such individuals who attempt to keep up with recent developments and be familiar with the fundamentals of all phases of gardening. They contribute both funds and time in these efforts. The associates meet regularly to listen to lectures by professional garden specialists and industrial representatives, and to pool their knowledge about customer questions.

Being able to provide service to customers has once again, refreshingly, become part of the modern scene.